

WHAT IS CLAIMED IS:

1. A portable device connectable to a battery pack including a secondary battery, the portable device  
5 comprising:

a charging circuit for charging the secondary battery when the battery pack is connected to the portable device, the charging circuit including a charging terminal used to supply the secondary battery with charging current and a  
10 voltage detection terminal used to detect voltage of the secondary battery in the battery pack, the charging circuit stopping charging of the secondary battery if a voltage abnormality is detected at the voltage detection terminal.

15 2. The portable device according to claim 1, wherein the charging circuit stops charging the secondary battery if a voltage abnormality is detected at the charging terminal.

3. The portable device according to claim 1, wherein  
20 the charging circuit includes:

a current detection resistor for detecting the charging current;

a current detection circuit connected to the current detection resistor to generate a current detection signal  
25 corresponding to the charging current flowing through the current detection resistor;

a first error amplifier connected to the current detection circuit, wherein the first error amplifier compares the current detection signal with a first reference  
30 voltage to obtain the difference therebetween and amplifies the difference to generate a first charge control signal with a voltage that causes charging to be performed at a constant current when the voltage at the voltage detection

terminal is normal; and

a second error amplifier connected to the voltage detection terminal, wherein the second error amplifier compares voltage derived from the voltage of the secondary battery with a second reference voltage and amplifies the difference to generate a second charge control signal that causes charging to be performed at a constant voltage; and

wherein the first error amplifier is supplied with the voltage of the voltage detection terminal and generates the first charge control signal with a voltage that causes charging to be stopped when the voltage at the voltage detection terminal is abnormal.

4. The portable device according to claim 3, wherein the charging circuit further includes:

a charging suspension circuit connected to the first and second error amplifiers to generate a third charge control signal that causes charging to be stopped when the first and second charge control signals indicate that the voltage at the voltage detection terminal is abnormal.

5. The portable device according to claim 4, wherein:

the first error amplifier includes an inverting input terminal provided with the current detection signal, a first non-inverting input terminal supplied with the voltage of the voltage detection terminal, and a second non-inverting input terminal supplied with the first reference voltage;

the second error amplifier includes an inverting input terminal supplied with a divisional voltage of the voltage of the secondary battery and a non-inverting input terminal supplied with the second reference voltage; and

the charging circuit includes an inverting input terminal supplied with a third reference voltage, a first

non-inverting input terminal provided with the first charge control signal, and a second non-inverting input terminal provided with the second charge control signal.

5           6.    The portable device according to claim 5, wherein the charging circuit further includes:

          a triangular wave oscillator for generating a triangular wave signal; and

          a PWM comparator connected to the triangular wave  
10 oscillator, the first and second error amplifiers, and the charging suspension circuit, wherein the PWM comparator is provided with the first to third charge control signals and the triangular wave signal to generate a PWM signal having a predetermined duty ratio in accordance with the result of a  
15 comparison between one of the first to third charge control signals and the triangular wave signal.

          7.    The portable device according to claim 6, wherein:

          the first reference voltage is a voltage for setting a  
20 constant current value related with the constant current charging;

          the second reference voltage is a voltage for setting a constant voltage value related with the constant voltage charging; and

25           the third reference voltage is substantially the same as the maximum voltage of the triangular wave signal.

          8.    The portable device according to claim 1, wherein the charge circuit is a remote sense type circuit for  
30 directly detecting voltage at a positive terminal of the secondary battery in the battery pack and charging the secondary battery.

9. A semiconductor device for use in a charging circuit of a portable device connectable to a battery pack including a secondary battery, wherein the charging circuit charges the secondary battery when connected to the portable device supplies the secondary battery with charging current, and includes a voltage detection terminal used to detect voltage of the secondary battery in the battery pack and a current detection resistor for detecting the charging current, the semiconductor device comprising:

a current detection circuit connected to the current detection resistor to generate a current detection signal corresponding to the charging current flowing through the current detection resistor;

a first error amplifier connected to the current detection circuit, wherein the first error amplifier compares the current detection signal with a first reference voltage to obtain the difference therebetween and amplifies the difference to generate a first charge control signal with a voltage that causes charging to be performed at a constant current when the voltage at the voltage detection terminal is normal; and

a second error amplifier connected to the voltage detection terminal, wherein the second error amplifier compares voltage derived from the voltage of the secondary battery with a second reference voltage and amplifies the difference to generate a second charge control signal that causes charging to be performed at a constant voltage;

wherein the first error amplifier is supplied with the voltage of the voltage detection terminal and generates the first charge control signal with a voltage that causes charging to be stopped when the voltage at the voltage detection terminal is abnormal.

10. The semiconductor device according to claim 9, wherein the current detection circuit, the first error amplifier, and the second error amplifier are configured on a single semiconductor substrate chip.

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11. The semiconductor device according to claim 9, further comprising:

a charging suspension circuit connected to the first and second error amplifiers to generate a third charge control signal that causes charging to be stopped when the first and second charge control signals indicate that the voltage at the voltage detection terminal is abnormal.

12. The semiconductor device according to claim 11, wherein:

the first error amplifier includes an inverting input terminal provided with the current detection signal, a first non-inverting input terminal supplied with the voltage of the voltage detection terminal, and a second non-inverting input terminal supplied with the first reference voltage;

the second error amplifier includes an inverting input terminal supplied with a divisional voltage of the voltage of the secondary battery and a non-inverting input terminal supplied with the second reference voltage; and

the charging circuit includes an inverting input terminal supplied with a third reference voltage, a first non-inverting input terminal provided with the first charge control signal, and a second non-inverting input terminal provided with the second charge control signal.

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13. The semiconductor device according to claim 12, further comprising:

a triangular wave oscillator for generating a

triangular wave signal; and

a PWM comparator connected to the triangular wave oscillator, the first and second error amplifiers, and the charging suspension circuit, wherein the PWM comparator is provided with the first to third charge control signals and the triangular wave signal to generate a PWM signal having a predetermined duty ratio in accordance with the result of a comparison between one of the first to third charge control signals and the triangular wave signal.

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14. The semiconductor device according to claim 13, wherein:

the first reference voltage is a voltage for setting a constant current value related with the constant current charging;

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the second reference voltage is a voltage for setting a constant voltage value related with the constant voltage charging; and

the third reference voltage is substantially the same as the maximum voltage of the triangular wave signal.

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15. The semiconductor device according to claim 14, wherein the current detection circuit, the first error amplifier, the second error amplifier, the charging suspension circuit, the triangular wave oscillator, and the PWM comparator are configured on a single semiconductor substrate chip.

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16. A method for charging a secondary battery of a battery pack with a portable device that is connectable to the battery pack, wherein the battery pack includes a first voltage detection terminal used to detect voltage of the secondary battery in the battery pack, and the portable

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device includes a second voltage detection terminal connected to the first voltage detection terminal, the method comprising:

5 connecting the battery pack to the portable device and supplying charging current to the battery pack from the portable device;

detecting the charging current and generating a current detection signal that is in accordance with the charging current;

10 comparing voltage of the current detection signal with voltage at the second voltage detection terminal; and

stopping the supply of charging current to the battery pack from the portable device in accordance with the result of the comparison.

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17. The method according to claim 16, wherein said stopping the supply of charging current includes stopping the supply of charging current to the battery pack from the portable device when the voltage of the current detection  
20 signal is greater than the voltage at the second voltage detection terminal.